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Microclimatic and Crop Responses to Center Pivot Sprinkler and to Surface Irrigation*

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Summary. Over 1 million hectares are irrigated with center pivot sprinklers in the Great Plains, USA. Microclimatic conditions under center pivot systems will be affected somewhat by periodic sprinkling, but the extent of microclimatic modification to be expected from sprinkling in the High Plains region and the physiological implications have not been reported.

We compared the leaf temperature, canopy air temperature, vapor pressure deficit, vapor pressure, soil temperature, and soil heat flux in a corn (Zea mays L.) canopy under center pivot sprinkler and surface irrigation. The crops were grown at Garden City, Kansas, in 1980, a hot, dry year, and in 1981, a relatively cool, wet year. Leaf and air temperatures in 1980 were significantly cooler under sprinkler irrigation than under surface irrigation. Maximum, minimum, and mean daily leaf temperatures were reduced by 2°, 2°, and 1° C, respectively; and maximum, minimum, and mean canopy air temperatures were reduced by 3°, 1.5°, and 1.5° C, respectively. Leaf and minimum canopy air temperature reductions were significant at the 1% level. Shorter irrigation intervals may explain the reduced stress on the sprinkled plots. We observed small, nonsignificant temperature reductions under the sprinkler in the 1981 season. No significant effects of irrigation type on vapor pressure deficit or on vapor pressure in the canopy were observed in 1980 or 1981. Analysis of the 1981 data indicated that most of the day-to-day variability in leaf and canopy temperatures is related to ambient air temperature and that canopy vapor pressure deficit and vapor pressure are related to both ambient temperature and ambient vapor pressure deficit. Soil temperatures were significantly reduced and soil heat flux increased under sprinkler irrigation.

The diurnal response to sprinkler irrigation cycles was pronounced during early stress periods of the 1980 growing season. Leaf and canopy air temperature and vapor pressure deficit were all significantly lower throughout the day in recently

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irrigated areas compared to areas that were sprinkled one or two days earlier. Responses to sprinkling during nonstress periods of 1980 and 1981 only persisted while the leaves were wetted; after, conditions returned to levels found in the rest of the field.

Introduction

About 6.5 million hectares of land in the Great Plains are irrigated from the Ogallala aquifer (Luckey et al. 1981). Withdrawals of water exceed recharge to the Ogallala in most areas under extensive irrigation. Water level is declining rapidly in many areas in the southern Great Plains.

About 18% of the land in the Great Plains is irrigated with center pivot sprinkler systems and acreage under center pivot systems is increasing faster than any other type of irrigation (McKnight, 1979). Sprinkler irrigation systems require more energy than surface irrigation methods because the water must be pumped through the system under pressure. Depleting water resources and increasing energy costs have made people realize that water pumped from the Ogallala must be used as efficiently as possible to maintain the profitability of irrigation and to prolong the life of the aquifer as a water supply (Luckey et al. 1981).

Many researchers have examined microclimatic effects of sprinkler irrigation. Kraus (1966) found increased relative humidity and decreased evapotranspiration (ET) immediately downwind from a sprinkled area. Robinson (1970) found vapor pressure increases and leaf temperature decreases caused by irrigation to be larger and more consistent under sprinklers than with flooding. Wiersma (1970) found decreased temperatures and reduced ET downwind from a sprinkler lateral. Rojek (1976) found decreases in temperature and vapor pressure deficit in a sprinkled corn field, which persisted after sprinkling. High value crops often are sprinkled for cooling purposes during periods of potential heat stress (Gerakis and Carolus 1970; Wright et al., 1981; and Chesness et al., 1979). Kohl and Wright (1974) found only small temperature reductions and relative humidity increases downwind from a sprinkler lateral under moderate environmental conditions in Idaho.

Howell et al. (1971) found increased (less negative) leaf water potential, decreased leaf temperature, and decreased stomatal resistance in misted peas. The yield was greater in misted treatments compared to peas receiving surface irrigation. Rassolow and Gorschkow (1980) reported higher yields of potatoes, sugar beets, and a pea/oat mixture under misting irrigation than under surface irrigation. Doss (1974) found no yield enhancement for corn under fog irrigation in Alabama.

The predominant crops grown in the Great Plains are relatively low value grain, forage, and fiber crops. Sprinkling for microclimatic modification is not economically feasible, even though climatic conditions are likely to be stressful, with high temperatures, windspeeds, radiation, and vapor pressure deficit conditions prevalent during the growing season. However, large acreages are sprinkled for irrigation purposes and this periodic sprinkling will have some effect on microclimatic conditions. No reports in the literature evaluate the extent of microclimatic

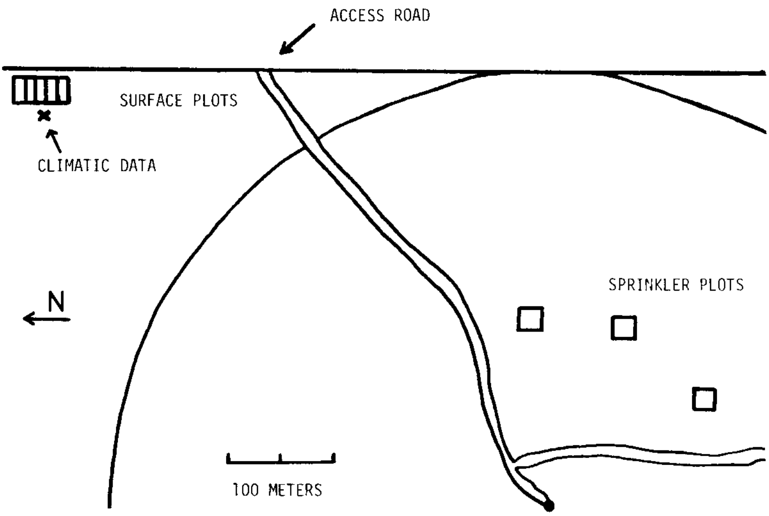

Fig. 1. Surface and sprinkler irrigated plots. Garden City, Kansas. 1980 and 1981

changes that occur in sprinkled fields under stressful conditions and the possible effects on crop growth.

We established this experiment to compare the microclimate of corn (Zea mays L.) grown under center pivot sprinkler and surface irrigation and to evaluate the significance of the difference. Seasonal applications on both systems were similar. Sprinkler applications were about 3.3 cm of water. Surface plots were irrigated less frequently, receiving about 9 cm of water at each irrigation.

Materials and Methods

Corn was grown at the Garden City Experiment Station in 1980 and 1981 on a Ulysses fine sandy loam (a fine-silty, mixed, mesic, Aridic Haplustoll). Sprinkler plots were 170 m from the center of a 400 m radius Zimmatic* center pivot system that was nozzled at a pressure of 379 kPa (55 psi) at the pivot with Senninger* low angle nozzles. The surface plots were irrigated in level basins located about 180 m from the sprinkler system (Fig. 1). In 1980, the basins were 15×15 m, surrounded on all sides by furrow irrigated corn. The area was releveled between the cropping seasons, and in 1981, 16×60 m plots were established adjacent to furrow irrigated corn on the north and irrigated sorghum on the other three sides. The minimum fetch to data collection sites was about 30 m. Sprinkler plots received about 3.3 cm of water per irrigation and surface plots received about 10.7 cm and 8.4 cm at less frequent intervals in 1980 and 1981, respectively. Different frequencies were selected to conform to common irrigation practices in the region.

Pioneer* 3183 corn was planted on 22 May and 4 June 1980 on the sprinkler and surface plots, respectively, and Pioneer* 3194 corn was planted on both plots

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* Inclusion of trade name is for information purposes only and does not constitute an endorsement by Kansas State University

on 22 May 1981. Corn was planted in 76 cm rows, oriented east-west on the surface, and circular on the sprinkler plots. Plant populations were 53,000 and 44,000 plants per ha in 1980 and 1981. Lower populations in 1981 were due partially to skipped spaces in the rows that occurred on both surface and sprinkler irrigated plots due to a malfunctioning planter. Crops were fertilized each year with 200 kg ha^{-1} of N, and had 1.12 and 3.92 kg ha^{-1} of Atrazine* and Sutan* applied in 1980 and 0.84 and 4.48 kg ha^{-1} of Atrazine* and Eradicane* (EPTC) in 1981 for weed control.

Leaf temperature and wet-dry bulb air temperatures were measured at three plots in the sprinkled field and at two level basin plots in 1980 and 1981 and additionally in furrow irrigated corn adjacent to the level basins in 1981. All temperature measurements were made at midcanopy height or at the ear level after the ears emerged. Leaf temperatures were measured with copper-constantan thermocouples constructed of 38 swg (dia = 0.152 mm) enameled wire with polyvinyl coating. The 38-gauge thermocouples were soldered to larger diameter extension wires for connection into a data acquisition system. Leaf thermocouples were threaded through the bottom side of the leaves, about one-third of the distance from the stalk to the leaf tip and about one-half of the distance from the midrib to the edge of the leaf. Leaf temperatures reported are the average of 10 measurements per plot. The wet-dry bulb psychrometers were located midway between rows and parallel to the row in each plot. Soil heat flux and soil temperature were measured in 1981 at a depth of 4 cm at one plot per field. Two and three soil heat flux plates on the surface and sprinkler plots, respectively, and three thermocouples were wired in parallel and arranged from row to midrow to give the average soil heat flux and soil temperature. Movement of energy into the soil profile was measured as a positive flux.

Data were scanned at 30-min intervals (with windspeed, wind direction, and solar radiation integrated over the scanning interval) on Campbell* CR-5 data loggers and stored on cassette tapes. Data for comparison of microclimatic conditions under the two irrigation systems were collected from 4 to 14 August 1980 and from 23 June to 16 August 1981.

Ambient climatic conditions were measured near the surface irrigated plots over an uncropped area. Windspeed and wind direction were measured at a 2 m height with a Gill* propeller vane anenometer. Solar radiation was measured with a LI-COR* LI-200S pyranometer. Wet-dry bulb temperatures were measured at 1.5 m with a psychrometer that we constructed. Rainfall was measured to the nearest 0.25 mm. Similar climatic data, collected about 2 km away at the Garden City Experiment Station at 60-min intervals, were used to replace missing values.

Leaf diffusive resistance and xylem water potential were measured periodically in July and August at midday. Abaxial and adaxial stomatal resistance of the upper, fully expanded leaves was made with a LI-COR* LI-65 autoporometer. The porometer was calibrated in the field prior to taking readings on the plants. Xylem water potential of upper leaves was measured by the pressure chamber method. Leaves were cut, placed in plastic ziplock bags, and carried to the instrument truck in a folder that was covered with a reflective Mylar. Readings were taken about 3 to 10 min after cutting. All values of stomatal resistance and xylem water potential reported are the average of at least three readings.

Statistical Analysis

Statistical analyses were made of the daily maximum, minimum and mean values of leaf, canopy air, and soil temperatures; vapor pressure and vapor pressure deficit within the canopy; and soil heat flux. In 1980 the analysis was conducted on 10 days' data and in 1981 on 54 days' data. The nature of the experiment precluded randomization of the assignment of treatment (type of irrigation) to plots.

Our experiment was a split-plot design with time as a subplot. In a normal split-plot design, one assumes independence in the assignment of subplots to the treatments. When time is the subplot, randomization is not possible and a correlation of data from a given plot over time is anticipated. Cox (1971) and Winer (1962) discuss analysis of data of this type by a conservative method that assigns 1 d.f. to time, since the correlation over time is unknown but could approach 1 without violating the assumptions of this test. The mean square of plot is used as the denominator for the F test on treatment. A summary of the analysis of variance is given in Table 1. For the analyses reported here, the F is tested assuming that the correlation of data over time could be as high as one. To determine the appropriate degrees of freedom for the test of F, one would have to determine the actual correlation over time of data points from a given plot; the subplot degrees of freedom would then be reduced proportionally to the correlation.

All data sets were edited to remove outliers and obvious bad data points before analysis was made. Periods of erratic data from particular thermocouples were identified and discarded until the thermocouple had been replaced. Wet-dry bulb temperatures were edited, first by comparing the data from various plots and then by examining the daily range in vapor pressure calculated from each plot. Some data indicated a diurnal range in vapor pressure of several kilo-Pascals and were discarded. All psychrometric data from one surface and one sprinkler plot were discarded in 1980 due to a large diurnal range in vapor pressure, indicating inadequate wicking by the wet bulb. Certain days or periods of data were discarded from each of the psychrometers in the 1981 data set because of a leak in the water reservoir, malfunction of the ventilating fans, or obvious deviation from other psychrometric data collected over the same period at the other plots. Also discarded were soil temperature and soil heat flux data collected before the first wetting of the soil.

Table 1. Analysis of variance with time as a subplot

Source	df	Conservative df	F
Irrigation type (trt)	1		MS_{trt}/MS_{plot}
Plot/irrigation type	4		
Day (subplot)	53		
Irr. type × day	53	1	$MS_{trt \times day}/MS_r$
Residual	212	4	
Total	323		

Results and Discussion

Seasonal Responses

We examined the effect of irrigation type on leaf temperature and air temperature, vapor pressure deficit, and vapor pressure in the canopy in 1980 and 1981. In addition, we compared soil temperature and soil heat flux under surface and sprinkler irrigation in 1981. Results of the analyses are presented in Tables 2 and 3. Climatic conditions in 1980 and 1981 were quite different (Table 4). The 1980 season was characterized by very high temperatures and low rainfall, especially in July and early August. The 1981 seasons was much cooler and had frequent rainfall, especially from mid-July to mid-August. Differences in the growing seasons affected the microclimatic responses to irrigation type.

Irrigation type had a strong effect on leaf and canopy air temperatures in 1980. Sprinkled leaf temperatures were cooled by almost 2° C for maximum and minimum temperature and by 1° C for daily mean temperature. Canopy air temperatures were cooled by about 3°, 1.5°, and 1.5° C for daily maximum, minimum, and mean temperatures, respectively. Lack of significance in the test of the effect of irrigation type on maximum canopy air temperature is due to variability in data from the two surface plots with one plot showing greater stress and higher temperatures than the other. Data from the sprinkler plots are similar and are all lower than the lowest surface plot temperature.

Differences in irrigation frequency might explain part of the cooling effect of sprinkling compared to surface irrigation during climatically stressful periods. Surface plots were irrigated just before and after the period when the 1980 data was collected, but not during the 11-day period. Sprinkler plots were irrigated just before and twice during the 11-day period. Because of high evaporative demand, surface plots were undergoing stress at the end of the irrigation cycle, even though soil moisture was above 50% of the available water. Sprinkled corn had soil moisture available at a higher potential in the upper part of the soil profile and was able to meet the evaporative demand and avoid stress. Rawlins and Raats (1975) proposed high frequency irrigation to improve the water use efficiency of crops through maintenance of high soil water potential in the root zone. Hobbs and Krogman (1978) and Thompson (1978) found increased yields of wheat and soybeans, respectively, with increased irrigation frequency. Hagan and Vaadia (1960) identified conditions which might require frequent irrigation, including high evapotranspiration rates, planting at the beginning of hot, dry weather, or major growth during hot, dry weather. Frequent irrigations may increase ET through increased evaporation from the soil, particularly before full canopy cover is achieved (Heermann and Shull 1976).

In 1981, which was a very moderate season with cooler than normal air temperatures and frequent rainfall (Table 4), the differences between surface and sprinkler irrigated corn canopies were much less than in 1980. Seasonal mean values show cooler temperatures on the sprinkled field but differences are not significant, except for the mean canopy air temperature. Even if cooler temperatures are real differences, they are unlikely to be physiologically important to the crop because the mean temperatures are lower and the differences between treat-

Table 2. Seasonal means of leaf and air temperature, vapor pressure deficit, and vapor pressure under surface and sprinkler irrigation. Garden City, Kansas. 1980 and 1981.

	Leaf Temperature			Canopy Air Temperature			Vapor Pressure Deficit			Vapor Pressure		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
	°C						kPa					
1980												
Surface mean	33.00	19.40	25.47	35.20	19.50	26.31	2.26	0.32	1.10	3.11	1.79	2.31
Sprinkler mean	31.13	17.67	24.47	31.90	18.50	24.83	2.30	0.25	1.10	2.55	1.67	2.02
Significance level of difference[a]	1%	1%	1%	n.s.	1%	10%	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Significance level of treatment × day interaction[a]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	5%	n.s.	n.s.	n.s.	5%	n.s.
1981												
Surface mean	30.76	17.77	23.61	33.05	18.72	25.06	2.10	0.11	0.90	2.90	1.88	2.33
Sprinkler mean	30.04	17.03	23.05	32.43	18.37	24.16	2.66	0.12	0.94	2.84	1.82	2.23
Significance level of difference[b]	n.s.	n.s.	n.s.	n.s.	n.s.	5%	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Significance level of treatment × day interactions[b]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

[a] Statistical analysis by F test with 1,3 df for leaf and air temperature and for treatment × day interaction analysis and 1,1 df for analysis of vapor pressure deficit and vapor pressure

[b] Statistical analysis by F test with 1,4 df

Table 3. Seasonal means of soil temperature and daily soil heat flux under surface and sprinkler irrigation. Garden City, Kansas. 1981

	Soil Temperature			Soil Heat Flux
	Max.	Min.	Mean	
	°C			MJ m^{-2} day^{-1}
1981				
Surface mean	31.81	21.60	25.98	0.18
Sprinkler mean	30.19	20.66	24.08	0.37
Significance level of difference[a]	1%	1%	1%	1%

[a] Statistical analysis by the paired t-test

Table 4. 1980, 1981, and normal monthly climatic data. Garden City, Kansas

	T_{max}	T_{min}	Days > 32 °C	Precip.	Global Radiation
	°C			mm	MJ m^{-2} day^{-1}
1980					
June	31.9	15.8	14	40.9	25.4
Juli	37.5	19.3	30	12.7	27.7
August	33.0	18.6	20	71.1	22.8
1981					
June	32.9	15.3	18	30.0	23.9
July	31.9	18.7	17	102.1	24.5
August	30.1	15.8	11	59.9	22.2
Normal					
June	30.4	15.3		74.2	27.2
July	33.8	18.3		61.7	26.9
August	32.4	17.8		58.9	24.8

ments are much smaller than found in 1980. In comparing data from 1980 and 1981, it is important to keep in mind that the 1980 data were collected during an 11-day period in early grain fill when climatic conditions were hot and dry, while the 1981 data were collected over a 54-day period from the 6-leaf stage through the early dough stage including a broader range of climatic conditions. Sprinkling a young crop would have a smaller and shorter duration effect because of less interception and a more open canopy.

No significant differences due to irrigation type were observed in canopy vapor pressure or vapor pressure deficit in either year. Plant surfaces are wetted for only a small proportion of the time and wetting did not contribute significantly to seasonal vapor pressure deficit differences. The actual sprinkling period resulted in a marked decrease of vapor pressure deficit within the canopy. With lower leaf temperatures in the sprinkler field in 1980, implying differences in transpiration

Table 5. Sum of squares of day partitioned to show the effects of ambient temperature, vapor pressure deficit and vapor pressure on day-to-day variability in canopy microclimatic responses. Garden City, Kansas. 1981

	Leaf Temperature			Canopy Air Temperature			Vapor Pressure Deficit			Vapor Pressure		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
SS_{DAY}	2104	944	1125	3762	921	1372	165.89	0.86	28.04	22.06	11.62	11.87
T_{amb}	1781	327	1048	2840	382	1299	98.74	0.24	16.93	8.41	0.93	3.23
VPD_{amb}	18	245	18	116	169	0	42.49	0.19	9.21	6.85	7.71	7.39
VP_{amb}	7	3	0	41	1	1	0.98	0.04	0.00	0.20	0.07	0.09
LOF[a]	299	419	59	765	367	71	23.68	0.39	1.89	7.13	2.90	1.16

[a] LOF has 36 df compared to 1 df for climatic variables. Contribution to mean squares will be smaller than the contribution to sum of squares

rates from the two treatments, one might have expected a higher vapor pressure or lower vapor pressure deficit in the sprinkled plots. The wet and dry bulb measurements were measured in the most open section of the canopy, between rows, and may have been more dominated by ambient conditions than were the leaf temperatures.

Soil temperatures were cooler under the sprinkler than under surface irrigation (Table 3). Differences in seasonal mean temperatures were quite small in 1981 but highly significant. Larger differences would be expected during a season with less frequent rainfall when surface irrigated plots would be wetted less frequently. Cooler soil temperature might affect microbial activity and chemical reactions in the soil but we did not measure the depth to which cooling occurred and cannot assess these responses. Daily flux of heat into the soil was about twice as large under the sprinkler than under surface irrigation (Table 3) but this flux was small and unlikely to be a significant part of the energy balance. For a crop which did not fully cover the soil surface for most of the irrigation season, the effect of surface soil moisture on the soil heat flux might be a more important component of the energy balance. Table 5 shows the sum of squares (SS_{day}) from the analysis of variance, with the variability for each analysis partitioned to show the proportion of the day-to-day variability which was releated to ambient temperature (T_{amb}), vapor pressure deficit (VPD_{amb}) and vapor pressure (VP_{amb}). Variability not explained by this method are shown as lack of fit (LOF). Other climatic variables (radiation, wind) were not strongly related to variability in the crop temperature or humidity.

Most day-to-day variability in leaf and canopy air temperature was related to variability in ambient air temperature. Ambient temperature and ambient vapor pressure deficit were both important in explaining daily variations in vapor pressure deficit and vapor pressure in the canopy.

Diurnal Responses to Sprinkler Irrigation Cycles

Marked microclimatic responses to the irrigation cycle were observed during the early stress periods of the 1980 season. Figure 2 shows diurnal leaf and canopy air temperatures on 19 July 1980 from two areas of the field, one watered two days prior to data collection and the other watered at 8:00 a.m. on the day of data collection. The area of the field that was sprinkled was immediately cooled. Leaf temperature dropped first, then air temperature. After leaf surfaces had dried, both leaf and air temperature increased, but that area of the field remained cooler throughout the day than the unsprinkled areas. Leaf temperature remained cooler than air temperature in the recently sprinkled area but exceeded air temperature at midday in the unsprinkled area. Temperatures at site C (sprinkled area) had exceeded temperatures in other parts of the field on preceding days.

Response to the irrigation cycle was not so pronounced through the entire season. Figures 3 and 4 compare leaf temperature and vapor pressure deficit responses in sprinkled and unsprinkled areas of the field on 19 July and 8 August 1980. Climatic conditions, measured at the Garden City Experiment Station (Table 6), were similar but higher temperatures and pan evaporation were measured on 19 July. The field was not stressed on 8 August, as evidenced by maximum leaf temperatures of about 31° C, well below maximum air temperature

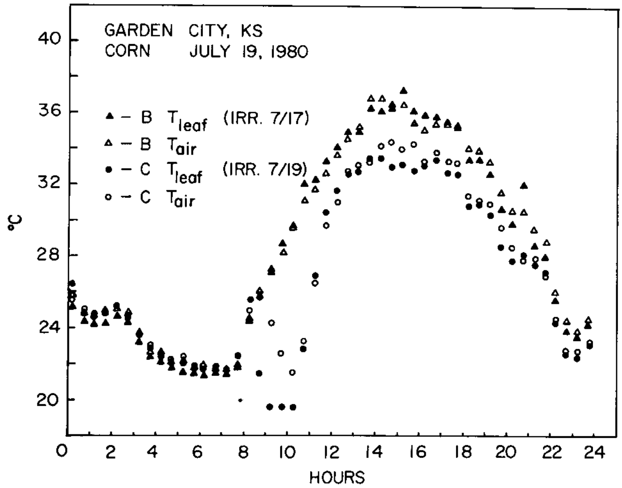

Fig. 2. Diurnal leaf and canopy air temperatures in recently sprinkled (C) and unsprinkled (B) areas of the sprinkler irrigated corn canopy. Garden City, Kansas. 19 July 1980

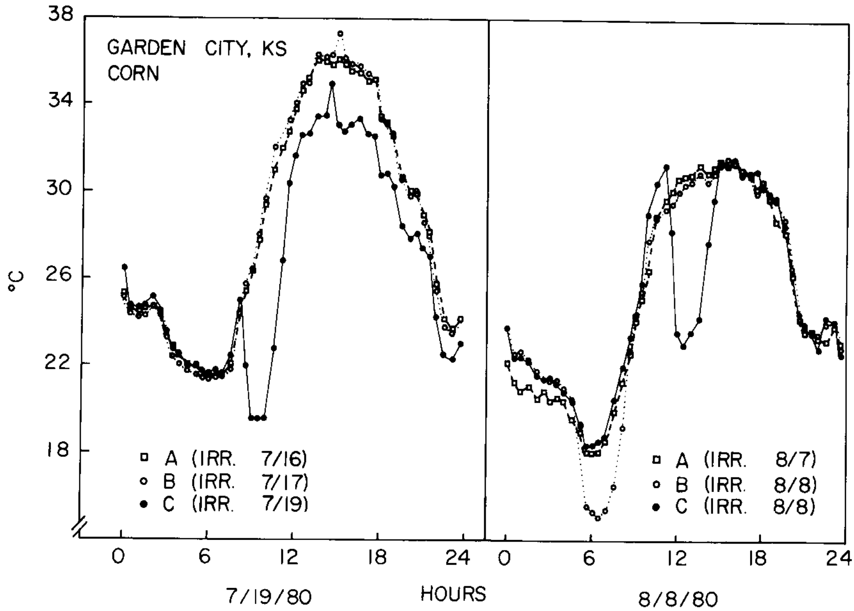

Fig. 3. Diurnal leaf temperatures in recently sprinkled and unsprinkled areas of the sprinkler irrigated corn canopy. Garden City, Kansas. 19 July and 8 August 1980

Table 6. Climatic conditions. Garden City, Kansas. 19 July and 8 August

	T_{max}	T_{mim}	R_s	Pan. Evap.	R.H.	Windspeed
	°C		MJm^{-2} day^{-1}	mm	%	$m\ s^{-1}$
July 19, 1980	38	21	23.8	18	59	2.42
August 8, 1980	36	18	23.2	15	69	4.53

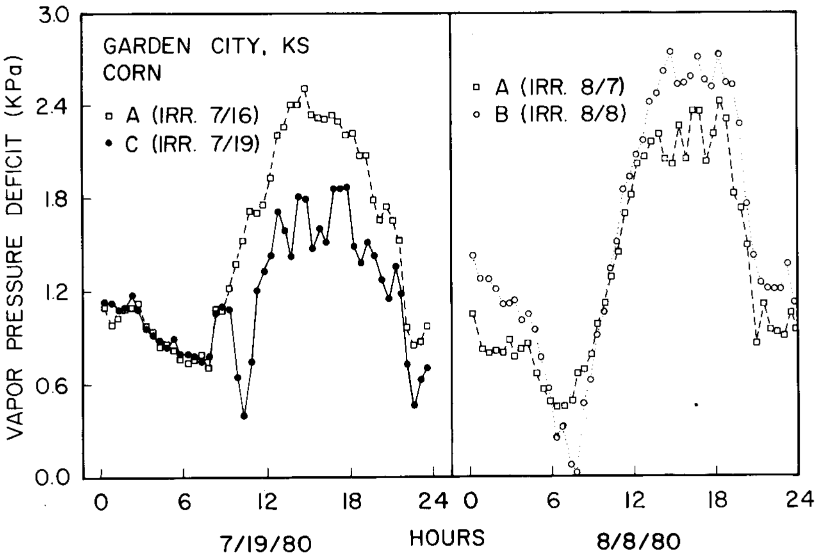

Fig. 4. Diurnal saturation vapor pressure deficit in recently sprinkled and unsprinkled areas of the sprinkler irrigated corn canopy. Garden City, Kansas. 19 July and 8 August 1980

of 36° C. Leaf temperatures dropped only while the canopy was wetted and then returned to the level found in unsprinkled parts of the field.

Vapor pressure deficit was much lower in the unsprinkled area of the field on 19 July throughout the day of sprinkling than in an area that had been sprinkled 3 days earlier. High leaf temperatures and high vapor pressure deficit in the unsprinkled area, relative to the sprinkled area, indicate stressed conditions and reduced transpiration. Vapor pressure deficit in the sprinkled area did not remain below that of the unsprinkled area on 8 August when the plants did not exhibit stress symptoms. Responses to irrigation cycles in 1981 were similar to those illustrated by the 8 August 1980 data with relatively short term responses of leaf and canopy air temperature and vapor pressure deficit to sprinkling.

Xylem water potential and stomatal resistance were measured from sunrise to sunset on 24 July 1980 in an area of the field that was watered just prior to sunrise and another area that was irrigated a day earlier (Fig. 5 and 6). Peak xylem water potential was less negative in the recently irrigated area than in the area watered the previous day. Paired t-tests indicate the xylem water potential of the recently sprinkled area was significantly higher (less negative) from 13:00 to 20:00 h. Stomatal resistance at the two areas was not different.

Xylem water potential measured on a surface irrigated plot (irrigated 18 July) was higher than on either area of the sprinkled plots. Stomatal resistance was similar on all surface and sprinkler irrigated plots. Measurements of xylem water potential and stomatal resistance taken on 5 August 1981 showed no differences in xylem water potential or stomatal resistance due to irrigation type or days since sprinkling. No evidence of water stress in either the sprinkler or surface irrigated plots was noted in 1981 and differences in the two treatments were less pronounced than in 1980.

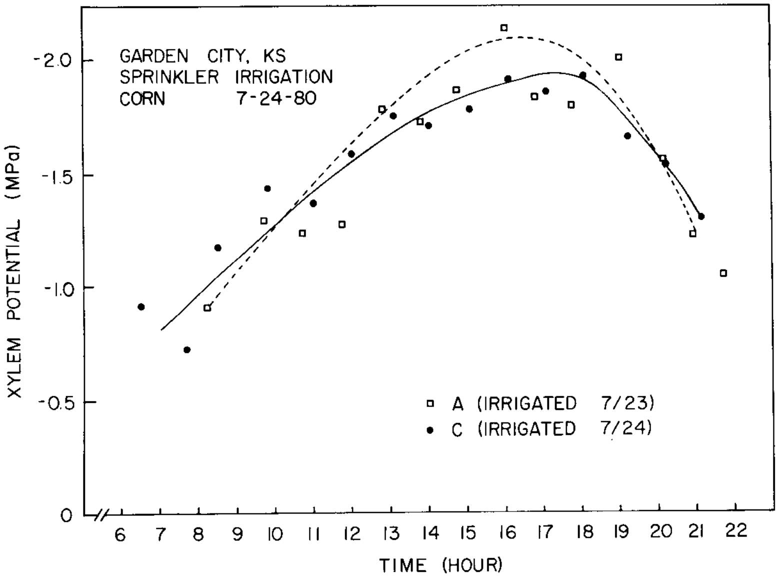

Fig. 5. Diurnal leaf water potential in recently sprinkled and unsprinkled areas of the sprinkler irrigated corn canopy. Garden City, Kansas. 24 July 1980

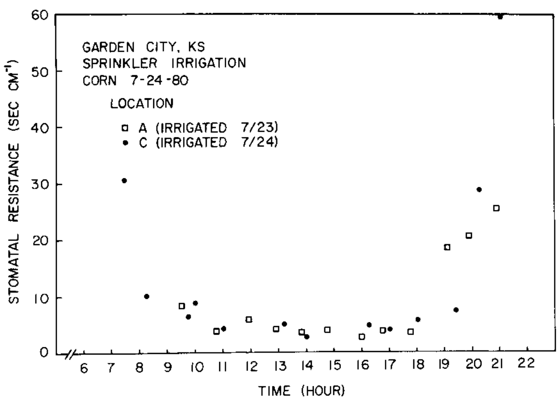

Fig. 6. Diurnal stomatal resistance in recently sprinkled and unsprinkled areas of the sprinkler irrigated corn canopy. Garden City, Kansas. 24 July 1980

Conclusions

Analyses of seasonal and diurnal microclimatic responses to sprinkler and surface irrigation indicate that sprinkler irrigation can provide cooling during stress periods. Part of the advantage of sprinkler irrigation may be the increased frequency of irrigation compared to surface irrigation methods. When evaporative demand is high, as is commonly found in the southern High Plains, frequently applied water will be held at a high soil water potential near the surface and will be readily extractable by the plant. During nonstress periods of crop growth, microclimatic and plant responses to sprinkler irrigation are much less than are seen during stress periods of the crop growth.

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